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In the present paper, I seek to establish, first, that the a priori arguments against the infinite past are vital to the overall success of the *kalam* argument. Merely appealing to the big bang theory of the origin of the universe will not do the trick. In the second place, I show that neither of these arguments is at all successful in showing that "metaphysical time" has a beginning. Along the way, various discoveries are made about the relation of dynamic time to the possibility that the past has no beginning. The final section of the paper shows that if (as is commonly assumed) there is a complete body of truth about the future, then an endless future is (also) an actual infinite.

Proponents of the *kalam* cosmological argument[1] seek to establish, not only that the beginning of the universe has a cause, but also that the cause of this beginning is a *first* cause – one not caused by any prior cause. It is therefore important to their overall project to establish that the series of events (if any) leading up to the creation of the universe also has a beginning.

This may seem unnecessary. *Time*, it may be said, came into existence along with the physical universe, so that it is not even *meaningful* "to ask what happened before the big bang."[2] It is far from clear, however, that this is the right way to look at things.

To see this, suppose that the big bang was caused by a personal agent who did some other things first. To borrow an example from William Lane Craig, the Creator could have done a sort of "count down" to creation: *Five, four, three, two, one, Let there be light!*[3] Had he done so, there would have been a temporal series of distinct mental events leading up to the creation of the physical universe.

Craig has called this a "knockdown argument" for the conclusion that "time as it plays a role in physics is at best a measure of time rather than constitutive or definitive of time."[4] He believes that time itself – or metaphysical time, as he calls it – is tensed, dynamic, and non-relative. On this view of time, there is an ever changing fact of the matter about which events are future, which present, and which past. Future events become present, present events become past, and past events sink ever further into the past.

We have just seen that a series of mental events succeeding one another in this kind of time is at least conceivable independently of the existence of our universe. But there also does not seem to be any a priori bar to the possibility of a temporal series of *non*-mental events occurring prior to the

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beginning of our space-time. If he had wanted to, God could have created a whole series of universes, each with its own history and its own special laws, prior to creating ours. Alternatively, one universe might have arisen from the ruins of a previous one without any special divine intervention. We may not have an adequate *theory* to explain how this could have happened, but it is one of the logical possibilities.[5]

This might seem to leave open the further possibility that the cause of our universe is only the most recent in an infinite temporal series of causes and effects. However, most proponents of the *kalam* cosmological argument believe that this can be ruled out on purely a priori grounds. Craig, for example, deploys two distinct philosophical arguments for saying that time (and not just the universe) must have a beginning.

According to the first of these arguments, an infinite series of past events is impossible because no actually infinite set of objects can be instantiated in reality. According to the second argument, an infinite series of past events would be impossible whether or not an actually infinite set of simultaneously existing objects could be instantiated in reality. The reason given is that no infinite series formed by "successive addition" can be completed.

Unfortunately, I believe that neither of these philosophical arguments is successful. In the next two sections, I take aim at the successive addition argument. The remainder of the paper will be devoted to Craig's argument against the possibility of an actual infinite.

The successive addition argument

Craig summarizes the successive addition argument as follows.

1. The temporal series of past events is a collection formed by successive addition.
2. A collection formed by successive addition cannot be actually infinite.
3. Therefore, the temporal series of past events cannot be actually infinite.[6]

On a dynamic theory of time, premise 1 seems straightforward enough. It says that the events in the series of past events have happened successively, one after the other. Each event has become past, followed by another which also became past, up until the present.

But what about premise 2? Why can't a collection formed in this step-by-step way have infinitely many members? Craig's answer is that an infinite collection can never be completed. No matter how many members are added to the collection, one could always add another. So no matter how many are added, the number of elements in the collection is necessarily finite. Infinity never arrives.

This is obviously how it is with any series *having a temporal beginning*. Consider, for example, the series of years that began on January 1, 1901. One hundred of its member years have passed by. The hundred and third is nearly completed. But no matter how many years are added, only finitely many years will have been added to this series. The series of years beginning on January 1, 1901 will never be a *completed infinity*.

But what about a series *having no temporal beginning*? Why couldn't there have been an infinite series of years in which there was no first year? It's true that in such a series we never "arrive" at infinity, but surely that is only because infinity is, so to speak, "always already there." At *every* point in such a series, infinitely many years have *already* passed by. Where, it may be asked, does Craig think he has shown that an infinite series of past events must *arrive* at infinity?

It might be thought that this objection overlooks the reality of temporal becoming. If a series of events is formed by the successive addition of one event after another, how can it fail to have a first member? I answer: Whether this conclusion follows depends on what is meant by saying that a series is *formed by successive addition*. If this is only a way of saying that each event in the series is added to the earlier ones (if any) until the series is complete, then it is certainly true that the series of past events is formed by successive addition. But from this alone it does *not* follow that there is a first event in the series. Each event in a *beginningless* series terminating in the present could have been "added" to the infinitely many prior events. (If you have a problem with this, it is probably because you have a more general problem with the actual infinite. More on this below.)

I fear that what defenders of the *kalam* argument really mean when they say that any temporal series must be *formed by successive addition* is something like this: *Beginning with the first event in the series*, events are successively added until the series is complete. But now premise 1 of the argument is the problematic premise. It is utterly question-begging to assume that *every* series of events must have been formed *starting* with a first event. Certainly, nothing like that follows from a dynamic theory of time.

However, Craig denies that his argument makes this question-begging assumption. "The fact that there is no beginning at all, not even an infinitely distant one," he says, "makes the difficulty worse, not better."[7] And he joins G. J. Whitrow in urging that the question of how an infinite sequence of events "could actually be produced" has been "ignored."[8]

But surely it is Craig who has not properly faced up to the question how a beginningless sequence of past events would be "produced." He supposes that it would have to be by "successive addition." But can he explain what he means by "successive addition" in such a way as to make premise 2 of his argument true? Can he do so without presupposing that the series of past events must have a beginning? I see no reason to believe that he can.

An incautious reasoner might be tempted to suppose that since the past is composed of events that have "passed away" – beginning, enduring, and coming to an end – the past *as a whole* must have "passed away" in this same sense. But when we are thinking clearly, and do not fall into a fallacy of composition, we see that this does not follow *unless* it is also assumed that the past has a beginning. And that, let us not forget, is the very point at issue.

I conclude that a dynamic theory of time does not by itself commit us to the view that "formation by successive addition" entails "formation *from* a starting point." Consequently, we have no reason to accept premise 2 of the successive addition argument.

Why didn't it all happen earlier?

So far, I have been defending the possibility that infinity is "always already there" – that at every point in the series of past events, infinitely many others have already passed by. Craig attacks this suggestion directly. "If the universe did not begin to exist a finite time ago," he says, "then the present moment could never arrive."[9] He explains and defends this claim by way of the following imaginary example:

> ... suppose we meet a man who claims to have been counting from eternity, and now he is finishing: -5, -4, -3, -2, -1, 0. Now this is impossible. For, we may ask, why didn't he finish counting yesterday or the day before or the year before? By then an infinity of time had already elapsed, so that he should have finished. The fact is, we could never find anyone completing such a task because at any previous point he would have already finished.[10]

I do not think this is a good argument. It confuses "having counted infinitely many negative numbers" with "having counted all the negative numbers up to zero." The man in Craig's example has indeed always already completed the first of these tasks; but he has not completed the second one until he arrives at zero. When he arrived at –1 he completed a different task – that of counting all the members in the series < .., –n, .., –2, –1 >. When he arrived at –2, he completed yet another task – that of counting all the members in the series, < .., –n, .., –3, –2 >. And so on.

Craig has tried to answer this obvious objection. In order to show that an infinite count could have been completed, he thinks his opponent must appeal to the Principle of Correspondence, according to which two sets have the same number of members if they can be placed in one-to-one correspondence.

> On the basis of this principle the objector argues that since the counter has lived, say, an infinite number of years and since the set of past years can be put into a one-to-one correspondence with the set of negative numbers, it follows that by counting one number a year an eternal counter would complete a countdown of the negative numbers by the present year. [11]

Notice how deftly Craig shifts the burden of proof to his opponent here. The objector may not have intended to give an argument *for* saying that a beginningless count *is* genuinely possible. He may merely have been asking Craig to show that it is *not* possible, and pointing out that he has not done so until he has excluded a certain *apparent* possibility.

But let that pass. Having attributed this argument for the infinite past to his opponent, Craig presses home his own point. Why, he asks, wouldn't the counter finish "next year or in a hundred years?" He supposes that the only reply available to his opponent is to say that "prior to the present year an infinite number of years will have already elapsed, so that by the Principle of Correspondence, all the numbers should have been counted by

now." Since this is precisely the reasoning the opponent objected to when he accused Craig of confusing counting *infinitely many* numbers with counting *all* the numbers, Craig concludes that the objection "backfires" on his opponent.[12]

This dialectical maneuver of Craig's is puzzling, to say the least. If his opponent were to respond in the way suggested, then he would have made the same mistake as Craig. But it doesn't follow that it is not a mistake or that Craig has not made it.

Craig apparently thinks that this is what his opponent *must* say. But in this he is surely mistaken. The proper response to the question why the counter wouldn't finish "next year or in a hundred years" is *not* to say, "Because infinitely many numbers *can* already have been counted by now." It is rather to turn the question back at Craig, and ask why the count should *not* be ending now. Why *should* it end later than now? No doubt there *could* have been a beginningless count ending in zero "next year or in a hundred years." But it does not follow that there cannot *also* be one terminating in the present. Certainly, Craig cannot show that a count ending in zero now is *not* possible merely by arguing that one ending in zero next year would *also* be possible.

To put the point a bit differently, why is this even a question that Craig's opponent needs to answer? Why does the opponent need to explain why the counter finished today rather than some other day? Why isn't enough to say, "That's how we imagined the case?"

It may be thought, however, that I have not properly appreciated the main thrust of Craig's argument. Although he doesn't spell it out clearly, perhaps the argument he really has in mind goes something like this. If a beginningless count were possible, there would *have to be* some reason why the counter finishes when he does. Since no such reason *can* be given, it follows that a beginningless count is not possible.[13]

Let's try to state the proposed argument a bit more carefully. When Craig asks, "Why didn't he finish counting yesterday (or tomorrow)?" he is asking:

> (CQ) Why is *the whole series* of "counting events" leading up to "zero" located at the beginningless series of temporal positions that terminates in the present, rather than at the beginningless series of temporal positions that terminated yesterday (or tomorrow)?

And the reason this question seems so compelling to him is that he is implicitly committed to something like the following argument:

1. If a beginningless count is possible, then there *must* be an answer to CQ – i.e., there must be a *reason why* the whole series of counting events is located at the series of temporal locations that terminates in the present.
2. No such reason *can* be given.
3. Therefore, a beginningless count ending in zero is not possible.

Does this argument succeed in establishing the impossibility of a begin-

ningless count? The first thing to see is that if we are to make sense of CQ (and premise 1), we must suppose that there are two distinct series – a series of past *counting events* and a series of past *times*. For convenience, let's suppose that the past is divided into segments of equal length and that each past event occupies one and only one of these segments of duration. Assuming that the series of past events is infinite, we can represent the two series as follows:

ES $< \ldots E_{-n} \ldots E_{-2}, E_{-1}, E_0 >$
TS $< \ldots T_{-n}, \ldots T_{-2}, T_{-1}, T_0 >$

Then what CQ amounts to is this: "Why do the events in ES map onto the chunks of duration in TS in the way that they do?" Since both series are beginningless, it could just as easily have been the case that E_0 happened at T_{-1}, E_{-1} at T_{-2}, and so on. So why does the series of events terminate at T_0 rather than at T_{-1} or at some earlier time? Why, for example, aren't they correlated in the following way?

ES $< \ldots E_{-n} \ldots E_{-2}, E_{-1}, E_0 >$
TS $< \ldots T_{-n}, \ldots T_{-2}, T_{-1}, T_0 >$

Now it is not immediately obvious that there *must* be an answer to CQ, or that the *possibility* of a beginningless count depends on the possibility of an answer to this question. Why couldn't it be a brute contingent fact that ES maps onto TS in the way that it does? Why couldn't CQ be one of those big questions that simply cannot be answered? Why couldn't it have a status comparable to that of other "stumpers" such as: Why is there anything at all? Or: Why *these* laws of nature?

To suppose that questions like these *must* have answers is implicitly to assume that something like Leibniz's Principle of Sufficient Reason is a necessary truth. Is it possible that Craig wants to rest his case on this highly controversial principle? That he assumes without discussion or argument that brute contingency is impossible? One wouldn't have thought so. After all, one of the strengths claimed for the *kalam* argument is that it makes do with the weaker (and more widely accepted) principle that whatever begins to exist must have a cause.[14]

But let that pass. Suppose, at least for the sake of argument, that if a beginningless count is possible then there must be an answer to CQ. Why should we also think that no answer is possible? Maybe the reason why the counting events in ES map onto the segments of duration in TS in the way that they do is that there is *another* beginningless series of events – call it ES* – such that the events in ES* are responsible for the ones in ES and such that the events in ES* map onto the segments in TS in that way? For example, there might be an eternal demon who has – always – been making the man count.

The possibility of this sort of answer to CQ won't get us very far, however. Not because it is logically impossible, but because it merely puts off the problem. The real underlying question is why the history of "reality" (including *all* the events that have ever happened at any time – whether

within or without the physical universe) did not reach its present *state* prior to the present *time*. Why not a year ago? Or two years ago?

So let us deepen our example, this time letting ES stand, not for a series of particular acts of counting, but rather for a series of past "macro-events," each of which includes *everything* that was going on at the time of that event. We can then think of these macro-events as a series of "temporal slices" of the history of "reality." And Craig's question would be – Why wasn't the whole series of temporal slices completed at an earlier time? Why wasn't *the whole infinite series of macro-events* leading up to the present one completed at T_{-1} or at T_{-2} or at some yet earlier time? Given the Principle of Sufficient Reason, there *must* be an answer. But assuming that the segments of time in TS are intrinsically indistinguishable from one another, it appears that no answer is possible.

How strong is this argument? On thing is clear. The argument won't go through unless we are entitled to think of the series of temporal segments in TS as being independent of the series of events in ES. This seems wrong to me. As far as I can see, the flow of (dynamic) time just *is* the continual happening of events, and the past just *is* the series of events that have already happened.[15] From this standpoint, there is no more mystery about the answer to the question, "Why does the series of *events* end at this time rather than some other?" than there is about the question, "Why does the series of *times* end with this time rather than some other?"

Someone might be tempted to reply that TS is independent of ES only in the sense in which a metric can be independent of something it is supposed to measure. But this will hardly serve the needs of the present argument. If TS is no more than a metric for ordering and measuring the succession of events in ES, the proper answer to the question, "Why does E_0 happen at T_0 rather than at T_{-1}?" will be nothing more exciting than, "Because that's how we applied our chosen metric to the series of events."

A simple analogy will make this clear. Suppose that we have a bolt of cloth, and a measuring stick, calibrated in inches, that we want to use to measure a ten inch swatch of cloth. Obviously, we can line up the end of the cloth with the end of the measuring stick, or we can line it up with the one inch marker on the measuring stick, or with the two inch marker, and so on. It's completely arbitrary which we decide to do. As long as we can do simple subtraction, we'll have no trouble measuring out a ten inch swatch of cloth. Now suppose someone asks, "Why is the edge of the stick lined up with the end of the cloth? Why not the one inch mark?" This is hardly a question that "cries out" for a "sufficient reason" type answer.[16]

The lesson is clear. In order to motivate the question, "Why T_0 and not T_{-1}?" the series of temporal segments in TS needs to be real and independent of the series of events in ES. It cannot be a mere metric, and its reality cannot consist wholly in the continual happening of the events in ES. But it is far from obvious that this is the right way to think about time. Indeed, the argument under consideration could be viewed, *not* as a reason for thinking that the series of events must have a beginning, but rather as a reason for not adopting a substantivalist theory of time.[17]

I conclude that the argument under consideration stands or falls with two highly controversial assumptions – (i) that the series of times at which

the whose series of events occur is ontologically independent of those events[18], and (ii) that something like the principle of sufficient reason would be applicable to the global correspondence between an infinite series of events and the series of times at which they occur.[19]

Hilbert's Hotel

Let's turn next to the other main philosophical argument against the possibility of a beginningless past. If the series of past events had no beginning, then the set of past events would be an actual infinite. But Craig thinks that the instantiation of an actual infinite in the real world would bring with it a number of implications sufficiently absurd to warrant the conclusion that no such set is possible. If this is right, it follows that the set of all past events is not actually infinite, in which case there must be a first event in the series of past events.

One of Craig's favorite illustrations of the absurdity of an actual infinite is "Hilbert's Hotel" – the famous imaginary hotel in which infinitely many guests occupy infinitely many rooms. The hotel has no vacancies, and yet space can always be found for new guests merely by cleverly reassigning the old guests to different rooms. No one has to leave the hotel to make room for the new guests. Craig thinks this is absurd – no matter how large the hotel, if it is full, one cannot create vacancies merely by moving the guests into different rooms.

Many philosophers would argue that the "absurdity" of Hilbert's Hotel is more apparent than real – that one shouldn't expect an infinite set to behave like a finite one. But others do seem to find the properties of an infinite hotel more than merely "weird." They are inclined to agree with Craig that such a thing could not exist in any possible world. I am not at all sure that they are right about this, but for the sake of argument, let us provisionally assume that Hilbert's Hotel really is impossible, on the ground that, no matter what the size of the hotel, it really is absurd to suppose that one could *create new vacancies merely by moving the guests to different rooms*. For ease of exposition, let's call this the *Absurd Implication*. How, exactly, is it supposed to follow that the series of past events could not be actually infinite? Craig explains:

> The actual infinite *entails*, that is, necessarily implies, that such absurdities could exist. Hilbert's illustration merely serves to bring out in a practical and vivid way what the mathematics necessarily implies; for if an actually infinite number of things is possible, then a hotel with an actually infinite number of rooms must be possible. Hence, it logically follows that if such a hotel is impossible, then so is the real existence of an actual infinite.[20]

Craig's reasoning may conveniently be outlined as follows:

1. Hilbert's Hotel is not possible. (On account of the Absurd Implication.)
2. If Hilbert's Hotel is not possible, then no actually infinite set is possible.

3. Therefore no actually infinite set is possible. (from 1 and 2)

And since

4. An infinite series of past events would be an actual infinite.

it also follows that

5. An infinite series of past events is not possible. (from 3 and 4)

We are assuming, for the sake of argument, that premise 1 is true. I have no quarrel with premise 4. But what about premise 2? Can we *generalize* the impossibility of a hotel with infinitely many rooms to *all* sets with infinitely many members?

It's not at all obvious that we can. Before leaping to the conclusion that infinite sets are impossible *in general*, we need to ask what it is in the example that generates the Absurd Implication and whether some analogous feature is present in all infinite sets.[21] In the case before us, I think the Absurd Implication follows from the way in which *infinity* interacts with other features of the example. A hotel is a collection of *co-existent* objects (rooms and guests) whose physical relationship to one another can be *changed*. It is only when these features are *combined* with the property of having infinitely many rooms and guests, that one can draw the Absurd Implication. If the rooms and guests did not exist simultaneously, the idea of the hotel's being "full" would lose all meaning. If it were metaphysically impossible to change the physical relationship between guests and rooms – if the guests were not the sort of thing that could be moved from one room to another, then they would exist immutably in their immutable rooms, and the Absurd Implication would again not follow.

What, then, does the "absurdity" of Hilbert's Hotel entitle us to conclude about the actual infinite? Not, I think, that no set of real objects could be actually infinite, but at most that there cannot be an actually infinite set *of a certain sort* – one whose elements are *co-existing* objects bearing a *changeable physical relationship* to one another. It is only when these features are taken together – as they are when we postulate infinitely many guests in a changeable relationship to the infinitely many rooms they occupy – that we get the Absurd Implication.

The "absurdity" of Hilbert's Hotel cannot therefore be generalized to *all* infinite sets. For example, it does not follow from the special impossibility of Hilbert's Hotel that there could not be infinite sets of numbers or other abstract entities. Craig, of course, denies that abstract entities exist "in reality." But he cannot show that he is right about this merely by pointing out that one cannot create vacancies in a hotel by moving the guests around. A Platonist about numbers is not committed to thinking that one can move the other numbers around so as to make "room" for a new one that one has just been "created." Numbers are simply not the sort of thing that can be shuffled around or created or changed in any other way.

More importantly for our purposes, there is no Hilbert's Hotel problem for an infinite series of past events. A temporal series of past events

cannot be changed or "manipulated" in such a way as to produce paradoxes analogous to those of Hilbert's Hotel. There is no sense whatever in the idea of shifting the events of the year 1939 to 1938, the events of 1938 to 1937, and so on, to "make room" for some other set of events that one wants to slip into the year 1939. And this is so *whether or not* the past has a beginning. The special impossibility of an infinite hotel (assuming still that it really is impossible) does not therefore entail that an infinite series of past events is impossible.

However, the following objection has been suggested to me.[22] Assuming (as Craig does) a dynamic theory of time, there is a sense in which the position of each past event in the temporal series is continually changing. Each past event sinks further and further into the past as new events become present and then past. But if the past is infinite, then (so the objection goes) every possible temporal location in the past is *already occupied* by a past event. Where, then, are present and future events supposed to go when they become past?

Do we now have a Hilbert's Hotel problem for the infinite past? I don't think so. It is true, of course, that on a dynamic theory of time, past events change their temporal location *in relation to the present*. And it also no doubt true that every one of the infinitely many past temporal locations is occupied by a past event. (If, as I suggested in section II, the passage of time just *is* the happening of events, then *of course* each temporal location will be occupied by some event or other.[23]) But why suppose that the past already contains all *possible* past times? Why not simply say that new temporal locations are continually *added* to the past to accommodate new events as they become past?

If we insist on comparing the series of past times to a hotel, we should compare it to an infinite hotel in which there is always room for new guests – not because the old guests are moved out of one room and into another – but because new rooms can be added to accommodate them. Nothing like the Absurd Implication follows from such a scenario.[24]

But perhaps the objector is thinking along the following lines. Suppose the temporal positions in the infinite past are numbered sequentially, one location for each negative number up to –1. Then all the negative numbers (and the corresponding temporal locations) are "taken" and none of them is available for the newly past event. Obviously enough, a new negative number cannot be created to accommodate the newly past event. Does it not follow that all possible locations are already occupied by the infinitely many past events?

No, it does not follow. The series of negative numbers functions here only as a set of *labels* for the series of temporal positions. No matter how many distinct temporal locations are added to the infinite past, one can always re-label them in such a way that they are placed in a (different) one-one-one correspondence with the negative numbers. Such a re-labeling obviously does not entail kicking events out of their previously held temporal locations. If we bother with labels at all, every past moment continually gets a new numerical "label" corresponding to its distance from the present. But that is not at all like physically moving guests from one set of rooms to another, and nothing like the Absurd Implication rears its ugly head.

As it happens, however, Craig has argued that such a re-labeling of the elements in an infinite set is impossible. He considers a similar suggestion in connection with another of his examples – the infinite library in which the books are numbered from zero onwards. Craig had argued that no books could be added to such a library, since all the numbers are already "taken," and Quentin Smith replied that the books might simply be re-numbered. Craig's reply is that this would violate "the initial conditions laid down in the argument", according to which we are to imagine "a series of consecutively numbered books beginning at 0 and increasing infinitely, not a series of books numbered from some finite number." "Once the objects are numbered as stipulated", Craig says, "reassigning the numbers to begin with the proposed addition seems *impossible*."[25]

I do not find this argument of Craig's at all convincing. Neither in the case of the infinite library nor in that of an infinite series of past events are we violating "the initial conditions" of the example. The "initial condition" in the library case is that the books are numbered from zero onwards, not that the numerals on the spines of the books are *immutably* attached to just those books. And the proposed "initial condition" in the case of the infinite series of past events is that they are correlated with the negative numbers – not that this particular correlation stays immutably the same. It is perfectly consistent with the example as I have described it to say that the way in which past events are correlated with the negative numbers is subject to continual change.

I think we may safely conclude that the special peculiarity of Hilbert's Hotel cannot be duplicated for an infinite series of past events. The Absurd Implication follows from Hilbert's Hotel *only* because of the way in which it *combines* the *infinite number* of rooms (and guests) with other features of the example. What has been "reduced to absurdity", therefore, is not the possibility of an actual infinite, but at most the *combination* of the actual infinite with these other features. Infinite sets that do not possess these features – such as an infinite series of past events – are not shown to be impossible by this Absurd Implication.

It is true, of course, that *any* infinite set (including Hilbert's Hotel) will have *other* implications that Craig believes to be absurd. The number of elements in the set of natural numbers is no greater than the number of odd numbers. So if the rooms in an infinite hotel are numbered from 1 onwards, then the total number of rooms is not greater than the total number of odd-numbered rooms. Similar things could be said about an infinite series of events or chunks of temporal duration. For example, if infinitely many hours have gone by, then the number of minutes that have passed is not greater than the number of hours (or days or weeks or months or years) that have passed by. And if that is absurd, then metaphysical time must have a beginning.

But all the rest of the window-dressing – all the talk about moving infinitely many guests from one room to another in an infinite hotel – is a distraction from the main issue. Even if these consequences of an infinite hotel are genuinely absurd, they cannot be generalized to *all* infinite sets in such a way as to show that an actually infinite series of past events is impossible.

Euclid's maxim about wholes and parts

So let's restrict ourselves to properties that are shared by all infinite sets. Would these properties lead to absurdity if they were instantiated in the real world? Craig thinks so. Since, as all must agree, the number of elements in any infinite set is *not greater than* the number of elements in infinitely many of its proper subsets, Craig thinks that *all* infinite sets necessarily violate a principle he refers to as "Euclid's Maxim."

EM A whole is greater than any of its parts.[26]

And since he believes that EM must be true of any set instantiated in the "real world," he concludes that there can be no infinite sets in the real world. If Craig is right about this, we have a completely general argument – one that, if sound, could be deployed even against an infinite series of events. But is he right?

The first thing to see is that Euclid's maxim about wholes and parts says nothing about the *number* of elements in a set. At most, it entails that *taken as a whole*, a set is *greater* than a mere *part* (a proper subset) of itself. This is important, because Craig's argument turns on the claim that an infinite set would *not* be "greater" than some of its parts, and because (as we are about to see) there is a perfectly straightforward sense in which an infinite set *is* greater than any of its proper subsets, even those having infinitely many members.

The example of an infinite hotel makes this clear. There is an obvious sense in which Hilbert's Hotel is "greater" than any of its parts, and this is so even though it does not have a greater *number* of rooms than some of them have. For instance, the hotel as a whole is "greater" ("larger") than the part of the hotel containing only rooms numbered 3 and higher *simply in virtue of the fact that it contains rooms numbered 0, 1, and 2 as well as all the higher numbered rooms*. This is all by itself a perfectly legitimate sense of the word "greater" – one that is logically independent of the question, "What is the *number* of rooms in the two sets?" In this sense, *any* set – even an infinite one – is "greater" than any of its parts. When the word "greater" is understood in this way, Hilbert's Hotel does *not* violate EM.

Euclid's Maxim, then, is not sufficient to get Craig's argument off the ground. His argument requires a principle that refers explicitly to the *number* of elements in a set. Something like the following would do the trick.

CM A set must have a greater *number* of elements than any of its proper subsets.[27]

But is CM true of all sets that might be instantiated in the real world? Everyone would agree that while it is true of all finite sets, it cannot be true of infinite sets (if there are any). But what should we conclude from this? That there can't be any infinite sets? Or merely that CM is true of finite sets, but not of *all* sets?

You might think Craig could break the impasse by exhibiting the various "absurdities" that would follow from the instantiation of infinite sets

in the real world. But as we have seen, the "absurdity" of Hilbert's Hotel follows only when infinity is combined with other features of the example that do not apply to all infinite sets. And as far as I can see, the other supposed "absurdities" Craig finds in infinite sets will be deemed "absurd" only by those who are *already* committed to something like CM. If you don't already think CM is true for *all* sets, you have no reason to think it "absurd" to suppose that the number of rooms in an infinite hotel is not greater than the number of rooms in some of its proper parts, or that the number of minutes is not greater than the number of hours in a beginningless past. Craig's examples doubtless bring out "anti-infinitist" intuitions in some people, but they do not settle the issue for the rest of us.

What is infinity minus infinity?

However, Craig insists that his argument against the actual infinite does not rest on Euclid's Maxim alone.

> ... not all the absurdities stem from infinite set theory's denial of Euclid's axiom: the absurdities illustrated by guests checking out of the hotel stem from the self-contradictory results when the inverse operations of subtraction or division are performed using transfinite numbers. Here the case against an actually infinite collection of things becomes decisive.[28]

What are these "self-contradictory answers?" They are the answers we get when we try to "subtract infinity from infinity." Here is one of Craig's explanations:

> Suppose the guests in room numbers 1, 3, 5, . . . check out. In this case an infinite number of people have left the hotel, but according to the mathematicians there are no less people in the hotel-but don't talk to that laundry woman! ... But suppose instead the persons in room number 4, 5, 6, ... checked out. At a single stroke the hotel would be virtually emptied, the guest register reduced to three names, and the infinite converted to finitude. And yet it would remain true that the *same number* of guests checked out this time as when the guests in room numbers 1, 3, 5, ... checked out.[29]

It is not immediately clear that there is any "contradiction" here that we need to worry about.[30] The supposed difficulty arises only if it is assumed that inverse arithmetical operations can be performed on the number of elements in any set that can be instantiated in the "real world." But why should we agree to operate on that assumption? In *Theism, Atheism, and Big Bang Cosmology*, Craig explains why he thinks so in terms of another of his examples – an imaginary infinite library.

> While we may correct the mathematician who attempts inverse operations with transfinite numbers, we cannot in the real world prevent people from checking out what books they please from our library.[31]

Craig's argument here is that since books can be checked out of any library in the "real world," inverse operations must be capable of being performed on the number of books in the library. Presumably Craig would give a similar argument for hotels. Since guests can check out of any hotel, inverse operations can always be performed on the number of guests.

Craig apparently assumes that a parallel argument is available for any set that could be instantiated in the "real world." If so, he is mistaken. The argument implicitly appeals to features of the infinite library (or the infinite hotel) that are *not* possessed by just any infinite set – and in particular are *not possessed by an infinite series of past events*. Whether or not the past is infinite, one cannot "remove" an event from the past. What has happened cannot (now) not have happened. So this particular motive for thinking that arithmetical subtraction must be possible does not apply to the case we are principally interested in.

But even as applied to infinite libraries and hotels the argument is a *non sequitur*. From the fact that $(\aleph_0 - \aleph_0)$ is undefined it does not follow that one cannot check books out of the imaginary library or that guests cannot leave Hilbert's Hotel. What follows is only that, depending on which books are removed, the *number* of volumes present in the library (or guests in the hotel) may or may not be smaller after their removal. That is indeed a characteristic of any actually infinite set, but it is hardly a "logical contradiction." And it is unlikely to bother anyone who is not already committed to CM.[32]

The Infinite Future

If there were a genuine contradiction here, this would have exceedingly unwelcome consequences for those who, like Craig, believe in the life eternal. By way of illustration, suppose that some created spirit will be saying "hallelujah" on a regular basis forever. Then infinitely many hallelujahs will be said in heaven. No matter how many have been said, infinitely many remain. (In the words of a much loved hymn, "When we've been there ten thousand years, bright shining as the sun, we've no less days to sing God's praise than when we first begun.") Now "subtract" every other hallelujah. The "remainder" is infinite. Next "subtract" all those that will be said after January 1, 2100. The "remainder" is finite. And yet the number of hallelujahs subtracted in each case is the same!

Craig would presumably grant that no matter how many hallelujahs *have been* said, another *will be* said. But he would insist there is no future time at which infinitely many of them *have* been said. The series of future hallelujahs is only *potentially* infinite. It is not therefore an infinite of the sort that he has a problem with.

Unfortunately, things are not this simple. While it is true that there will be no time at which infinitely many hallelujahs *have been* said, the fact remains that infinitely many *will be* said. This endless series of future hallelujahs can be placed in one-to-one correspondence to the series of natural numbers. Why isn't that sufficient to make the series of hallelujahs an actual infinite of just the sort the Craig finds so objectionable?

If is fairly clear how Craig would answer this objection. An event, he says, is "that which happens."[33] He holds that future events *do not exist*,

since they are not (yet) happening. Consequently, Craig believes that there is no set of actually existing future events. That is why he thinks a series of future events cannot be an actual infinite.

But how, one may ask, is that supposed to make the future different from the past? Future events are *not yet* happening. But it is equally true that past events are *no longer* happening. Should we then conclude that past events no longer exist, and that a beginningless series of past events would not be an *actual* infinite? No. Craig insists that past events do exist. Here is his explanation.

> Since past events, as determinate parts of reality, are definite and distinct and can be numbered, they can be conceptually collected into a totality. Therefore, if the temporal sequence of events is infinite, the set of all past events will be an actual infinite.[34]

But surely, one might reply, the future hallelujahs in our example are also "definite" and "distinct" and can be "numbered." If not by us, then by God. So how is this supposed to make the past different from the future?

I suppose someone might argue that the *particular* future hallelujahs in the sequence of future events cannot even be referred to, in which case they obviously could not be "conceptually collected into a totality." Is this at all plausible?

As far as I can see, there is only one way to make sense of this suggestion. If the future, unlike the past, were at least partly *indeterminate*, i.e., if there were genuine truth value gaps for at least some future tense propositions, then it would be open to Craig to hold that there is not a complete and determinate set of truths about each future hallelujah – in which case he might perhaps have some basis for arguing that we cannot refer to them, or treat them as future particulars that could be "conceptually collected into a totality."

This move is not available to Craig, however, since he believes that God has complete and infallible foreknowledge of the future. Indeed, he explicitly denies that there are truth value gaps for any future tense propositions, thereby committing himself to the view that there is – always – a complete body of truth about the future. It is therefore very hard to see how the endless series of future events is supposed to be *relevantly* different from a beginningless series of past events. If the latter can be "conceptually collected," so can the former. If we can speak meaningfully about particular future events, and formulate true propositions about them, then there is no reason at all why we cannot distinguish them from one another and number them. Since (as Craig agrees) there is no last member of the series of future events, they can be placed in one-to-one correlation with the series of natural numbers. And if that is sufficient to make an actual infinite out of a beginningless series of events that have happened, then it must surely do the same for the endless series of events that will happen. Given that there is a complete body of truth about the future, we must conclude *either* that the future is not endless *or* that it is an actual infinite.

Conclusion

I have tried to show that neither of Craig's philosophical arguments against the possibility of an infinite past is successful. This is important because it leaves open the possibility that the beginning of our universe was caused by the most recent in an infinite series of dependent causes. The *kalam* argument does not, then, provide a conclusive proof of a *first* cause.[35]

On the other hand, the *kalam* argument does force us to ask hard questions – Why did our universe come into existence? Where did it come from? – to which theists may believe they have a very good answer. Even if the conclusions of this paper are correct, it might still be the case that creation *ex nihilo* by a personal God is more *likely* than a beginningless series of dependent causes. How much (if any) more likely – and whether it is likely *enough* to warrant belief in God – are questions that must be left for another occasion.[36]

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NOTES

1. The term is derived from the phrase kalam Allah (Arabic for "word of God"). The kalam cosmological argument is so called in recognition of its advocacy by Muslim philosophers in the eighth to the tenth centuries. In our time, it has been stoutly defended by William Lane Craig, among others. The core argument has two premises and a conclusion. (1) Whatever begins to exist must have a cause. (2) The universe began to exist. Therefore (3) the universe has a cause.

2. J. Richard Gott III, James E. Gunn, David N. Schramm, Beatrice M. Tinsley, "Will the Universe Expand Forever?," *Scientific American*, March 1976, p. 65. Quoted by William Lane Craig in "Philosophical and Scientific Pointers to Creation *Ex Nihilo*", R. Douglas Geivett and Brendan Sweetman, eds. *Contemporary Perspectives on Religious Epistemology* (New York and Oxford: Oxford University Press, 1992), 185-200.

3. Adapted from William Lane Craig, "The Origin and Creation of the Universe: A Response to Adolf Grünbaum", *British Journal for the Philosophy of Science* 43 (1992), 233-240.

4. William Lane Craig, "Design and the Cosmological Argument", in *Mere Creation: Science, Faith and Intelligent Design*, ed. By William A. Dembski (Downers Grove, Ill.: InterVarsity Press, 1998), 350-1.

5. Craig sometimes argues against such possibilities on *empirical* grounds. For example, he claims that the most recent scientific evidence suggests that the universe is not headed toward a "big crunch," contrary to what is required by an oscillating theory of the universe. However, I do not think this is an especially strong reason for out-and-out *rejection* the possibility that our universe is the most recent in a series of universes. It is doubtless true that the present state of the scientific evidence does not *support* this possibility over any other that we can think of in our more speculative moments. But unless it is assumed that previous universes would have had the same basic composition and laws as ours, the possibility remains open that each of them ended in such a way as to enable the production of yet another universe. As far as the scientific evidence is concerned, the right course may simply be to suspend judgment about what

did or did not happen "prior" to the big bang. It is fun to speculate, but I doubt that the empirical evidence by itself warrants belief one way or the other. That is one reason why I think the a priori arguments for an absolute beginning discussed in this paper are so important to the success of the *kalam* argument.

6. "The Existence of God and the Beginning of the Universe," *Truth: A Journal of Modern Thought* 3 (1991): 85-96. (http://www.leaderu.com/truth/3truth11.html). For ease of exposition, I have reversed the order of Craig's premises and re-numbered them.

7. The precise way in which Craig thinks it makes the difficulty worse will be discussed in the next section.

8. "Professor Mackie and the Kalam Cosmological Argument." *Religious Studies* 20 (1985): 367-375.

9. "The Existence of God and the Beginning of the Universe."

10. "Philosophical and Scientific Pointers to Creation ex Nihilo", 189-90.

11. "The Existence of God and the Beginning of the Universe."

12. "The Existence of God and the Beginning of the Universe."

13. This line of argument was originally suggested to me by the comments of David Oderberg, who was the designated respondent to an earlier version of this paper that I presented at the meeting of the Evangelical Philosophical Association (in conjunction with the meeting of the American Academy of Religion) in Denver on November 18, 2001. However, I have developed the argument in my own way, and Oderberg is not responsible for my interpretation (or for any possible misunderstanding) of his remarks.

14. Indeed, Craig is careful to distance the kalam argument from the Leibnizian argument from contingency. See the introductory paragraphs of "The Existence of God and the Beginning of the Universe."

15. It is not entirely clear where Craig stands on this issue. He has for the most part defended a relational view of time on which it is impossible for time to exist in the complete absence of events (other than the passage of time itself). (See, for example, "Philosophical and Scientific Pointers to Creation ex Nihilo", 197-8.) That is why he thinks (i) that there could be no "empty" time prior to the first event, (ii) that God must be timeless "prior" to the first event in metaphysical time, and (iii) that God is the timeless creator of time. Nevertheless, I suppose it might be just possible for Craig to defend the view that, while the series of temporal intervals (TS) could not have existed without *any* events, it might have existed without *this* series of events (ES). In that case, the precise correlation between TS and ES might still be a contingent fact – and one that (given the principle of sufficient reason) would require explanation. As far as I can see, however, such a view of the relation between the passage of time and the happening of events has little to recommend it apart from the need to make out the present argument against the possibility of an infinite past. However a full and fair exploration of the ontological status of time is beyond the purview of the present paper.

16. Barbara Morriston suggested this example to me.

17. Such an argument would be somewhat similar to Leibniz's defense of the claim that "instants apart from things are nothing." Leibniz thought it was necessary to choose choose between the principle of sufficient reason and a substantivalist of time. See the third paper in the Leibniz-Clarke correspondence (paragraph 6), where Leibniz argues as follows: "Suppose someone asks why God did not create everything a year sooner; and that the same person wants to infer from that that God did something for which He cannot possibly have had a reason why He did it thus rather than otherwise, we should reply that his inference would be true if time were something apart from temporal things, for it would be impossible that there should be reasons why things

should have been applied to certain instants rather than to others, when their succession remained the same. But this itself proves that instants apart from things are nothing, and that they only consist in the successive order of things; and if this remains the same, the one of the two states (for instance that in which the creation was imagined to have occurred a year earlier) would be nowise different and could not be distinguished from the other which now exists." (*Leibniz: Philosophical Writings*, tr. by Mary Morris (E. P. Dutton: London and New York, 1956), 200.)

18. By "ontologically independent", I mean that it is possible in the "broadly logical" sense that those times could have existed without those events.

19. It is also interesting to note that this "sufficient reason" argument has nothing to do with the *successive addition* of events. To see this, imagine an infinite time of the B-series sort that is completely filled by an actually infinite series of events. Now arbitrarily designate a time T in the B-series of times. There are infinitely many temporal positions earlier than T, and infinitely many events located at those positions. Given well-known properties of the actual infinite, different pairings of events and times are logically possible. So one could just as easily ask, "Why are the infinitely many events located at this infinite series of times, rather than at some earlier infinite series of times?" Assuming that the B-series of times is (i) independent of the B-series of events, and (ii) that the B-series of times is completely homogenous, no answer is possible. That is a problem, of course, only if you accept a version of the Principle of Sufficient Reason strong enough to require an answer. But what is noteworthy here is that the argument has nothing to do with *successive addition* or with Craig's claim that one cannot complete an infinite series. Instead of giving a straightforward defense of the successive addition argument, it seems that we have merely changed the subject, offering a quite different line of argument against the infinite past.

20. William Lane Craig, *Reasonable Faith: Christian Truth and Apologetics* (Wheaton, Ill.: Crossway, 1984), 97.

21. That is, in any infinite set that might be instantiated in reality. Craig has always said that he has no wish to drive mathematicians from their "Cantorian paradise." But he also acknowledges that he is committed to a non-realist view of mathematics.

22. By David Oderberg. See note 11 above.

23. The event-bound view of time I have been assuming here might have to be qualified slightly to allow for the possibility of temporal gaps in which no events are occurring. But the possibility of such "gaps" would have no bearing on the present question, since newly past events are always added onto the "end" of the series of past events. Even if there were a temporal "gap" at the tail end of the series, the newly past event would not go into that gap but would come right after it.

24. This comparison is not perfect, of course. The rooms in the hotel are distinct from and independent of the guests who occupy them; whereas on the working hypothesis I have adopted, the passage of time just is the occurring of events. But see note 23.

25. *Theism, Atheism, and Big Bang Cosmology*, 96. My italics.

26. Actually, this is Euclid's fifth axiom. See William Lane Craig (with Quentin Smith), Theism, Atheism, and big bang Cosmology, 23ff.

27. The scope of CM should be limited to sets instantiated in the "real world." See note 16 above.

28. "The Existence of God and the Beginning of the Universe."

29. "The Existence of God and the Beginning of the Universe."

30. The issues are rather different with respect to transfinite ordinal arith-

metic. For a brief discussion, see Graham Oppy, "Inverse Operations With Transfinite Numbers and the Kalam Cosmological Argument", *International Philosophical Quarterly*, 35, 2, 219-221.

31. *Theism, Atheism, and Big Bang Cosmology*, 15.

32. And if it were contradictory, then, contrary to what Craig supposes, it would deprive mathematicians of their "Cantorian paradise." Logical consistency is at least as important in mathematics as it is in the "real world!"

33. *Theism, Atheism, and Big Bang Cosmology*, 24.

34. *Theism, Atheism, and Big Bang Cosmology*, 25.

35. Another set of implications is also noteworthy. If metaphysical time needn't have a beginning, then, contrary to what Craig supposes, there is no reason to think that there is a first event in God's life, and consequently no reason to think either that God is the creator of time or that he is timeless *sans* creation.

36. I would like to thank David Oderberg for an exceptionally stimulating set of criticisms directed at an earlier (and much slimmer) version of this paper. (See note 11 above.) I would also like to thank Barbara Morriston, Jonathan Peeters, and the Editor of this journal for their helpful comments and suggestions.